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M. U. F. FACTOR AND SOLAR ACTIVITY

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ABSTRACT. This paper deals with the variation of $M(3000)F_2$ factor with sunspot activity. The ionospheric data for Delhi and Ahmedabad for the period 1950 to 1958 have been considered. The analysis indicates that a fairly good linear relationship exists between $M(3000)F_2$ and sunspot number for both the places. A preliminary study of the variation of Y_m and h_o with sunspot activity (Ahmedabad) has also been made.

I. INTRODUCTION

The variation of $M(3000)\ F_2$—the maximum usable frequency factor for distance of 3000 kms for transmission through the F_2 layer—with sunspot activity has been studied recently by a few workers. Eyfrig (1951), following the variation of $M(3000)\ F_2$ (related to the layer height), has observed that there exists a linear relationship. Rawer (1952) has stated that the variation of the factor $M(3000)\ F_2$ can be taken as an index of altitude of the layer and that it is correlated with sunspot number. Allen (1953), however, has concluded that the variation of virtual heights is not related in any significant manner to either the sunspot cycle or the diurnal variation of f_0F_2. Theissen (1955) has attempted the evaluation of $M(3000)\ F_2$ for every hour by use of charts and has also considered the possibility of a world-wide forecast of these factors. Eyfrig (1957) has followed up his previous study and has shown that an unambiguous relation of $M(3000)\ F_2$ with change of solar activity exists for certain regions of the earth. He has, however, stressed therein, that the data is insufficient and sometimes contradictory to justify a world-wide examination.

The object of this paper is to study the variation of $M(3000)F_2$ with sunspot activity as observed from the data at Delhi and Ahmedabad—two Indian stations where ionospheric sounding has been in progress for the last few years. For Delhi (28°35′N, 77°5′E) data for years 1950 to 1958 and Ahmedabad (23°0 N, 72° 40′E) data for the years 1953 to 1958 have been analysed.

II. CALCULATION OF $M(3000)F_2$

Over the last few years, a detailed analysis of the structure of the F_2 layer has been made from the data from the different ionospheric stations in India. This analysis has shown that the assumption of a parabolic layer is a good approximation and for $Y_m/h_o \geqslant 0.2$ (where Y_m is the semi-thickness of the layer and h_o

is the height of the lower edge of the F_2 layer), the variation of the factor $M(3000)F_2$ with hpF_2 (height of maximum ionization density and equal to the height at 0.834 times $f_0 F_2$) can be represented by a curve, which appears to be a hyperbola (Fig. 1). This curve is obtained from a mass plot of $M(3000)F_2$ factors, (after

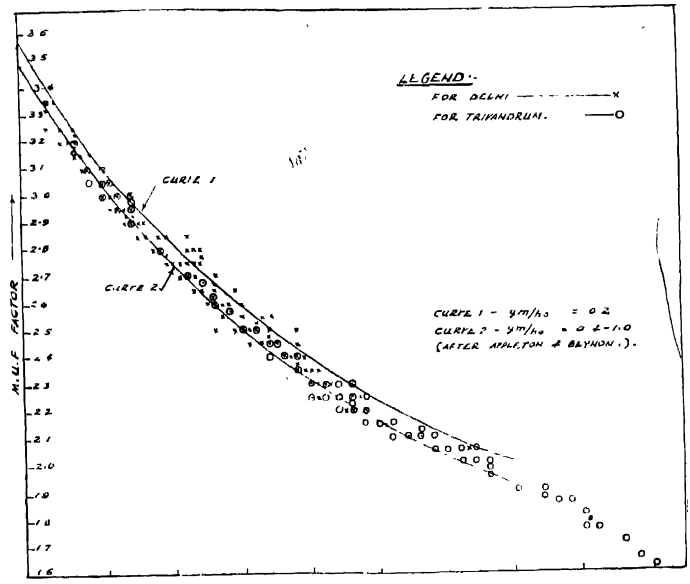

Fig. 1 Variation of $M(3000)F_2$ with h_m for Delhi and Trivandrum.

Appleton and Beynon 1941, 1947) against height of maximum ionization for different values of $M(3000)F_2$. Bibl and others (1951) have also stated that hp F2 may be related to $M(3000)F_2$ and that the curve expressing the relationship appears to be a hyperbola. The curve corresponding to $Y_m/h_0 = 0.4$ in Fig. 1 fits in best with the data for Indian stations.

All the $M(3000)F_2$ factors used in this paper have been obtained on the above basis.

The results of the analysis are discussed in the following sections.

III. DIURNAL AND SEASONAL VARIATIONS OF $M(3000)F_2$

Fig. 2 shows the diurnal variation of $M(3000)F_2$ for Delhi and Ahmedabad for sunspot minimum and maximum activity periods and for different seasons.

The predominance of the semidiurnal effect in the different seasons and in the different epochs of sunspot activity is quite evident The effect of Solar tides in producing semi-diurnal variations of f_0F_2 and h_pF_2 has already been described earlier (Rao, 1956).

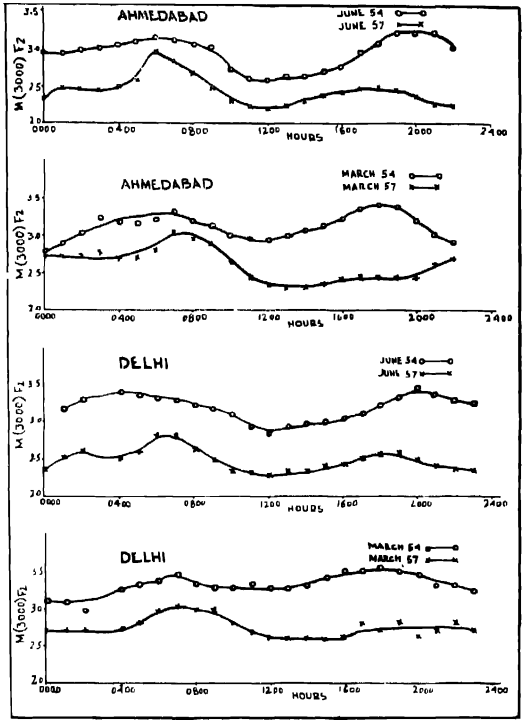

Fig. 2. Diurnal Variation of $M(3000)F_2$ for Delhi and Ahmedabad.

IV VARIATION OF 'M' WITH SUNSPOT ACTIVITY

Fig. 3 shows the variations of the 12 monthly running averages of $M(3000)$ F_2 as observed at Delhi and Ahmedabad with the 12 monthly running average of relative sunspot numbers for 1200 hrs. A study of these graphs indicates that a linear relationship between the $M(3000)F_2$ and sunspot number (R) would be a good approximation

Assuming a relation of the type

$$M_R = M_0 - bR \qquad \ldots \quad (1)$$

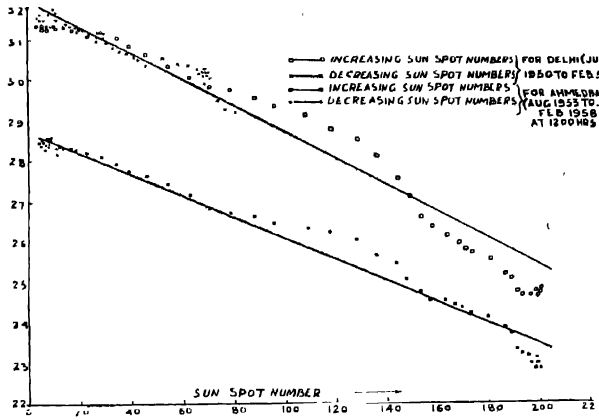

Fig. 3. Variation of running average of $M(3000)F_2$ with running average Sunspot numl

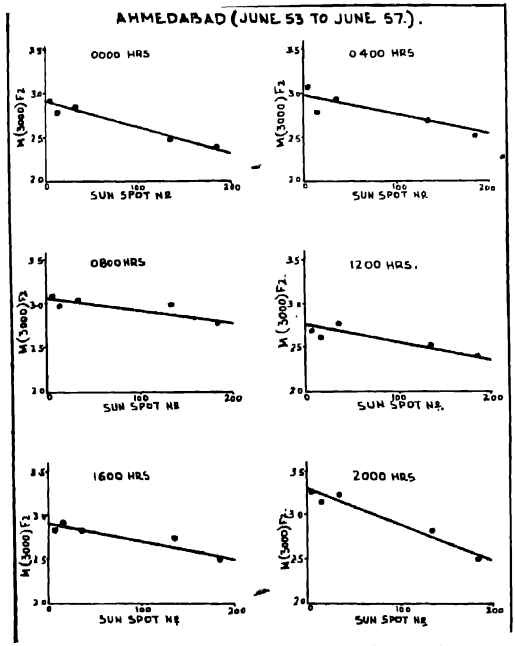

Fig. 4 Variation of $M(3000)F_2$ with Sunspot number for different hours for Ahamedabad

where M_R is the $M(3000)F_2$ factor for a sunspot number R, M_0 the same quantity for sunspot number zero and b the sunspot variation factor, the values of M_0

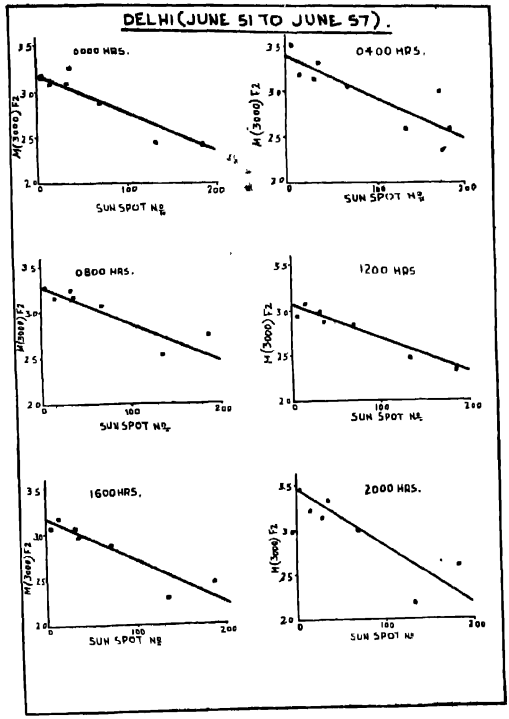

Fig. 5. Variation of $M(3000)F_2$ with Sunspot number for different hours for Delhi.

and b and correlation co-efficient r between M_0 and R have been obtained and are shown in Table I.

TABLE I

Station	M_0	b	r
Delhi	3.22	0.00360	0 990
Ahmedabad	2 87	0.00266	0 971

The slow variation of M with sunspot number is apparent from the values given in the above table and the high values of r obtained justify the linear relationship assumed in Eq. 1

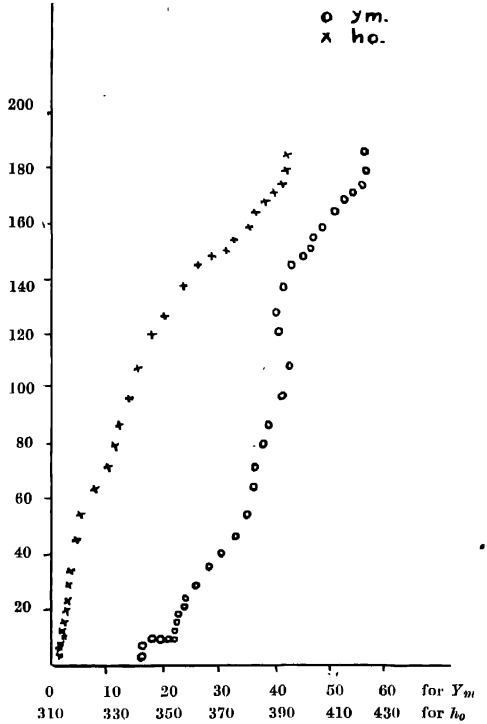

Fig. 6. Variation of Y_m and h_0 with Sunspot number for Ahmedabad.

The variation of $M(3000)\,F_2$ with sunspot number has also been studied for other hours. A few typical graphs showing the variations for Delhi and Ahmedabad for the month of June for different hours of the day are shown in Figs. 4 and 5 respectively. From these figures it is clear that the linear relationship assumed in Eq (1) can be extended to other hours of the day also.

V. VARIATION OF Y_m AND h_0

An initial study of the variation of Y_m and h_0 of the F_2 layer at Ahmedabad with sunspot activity has been made. The data have been taken from those lished by the Physical Research Laboratory, Ahmedabad. The variations

Fig. 4.

of Y_m and h_o (running average values of 12 months) with R are shown in Fig 6, from which it may be seen that both Y_m and h_o increase in a linear manner with increase in R.

From these graphs it is seen that the same ratio of Y_m/h_o is maintained throughout the sunspot cycle.

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